REMARKS

Examiner Kielin is thanked for his ongoing and careful examination of the subject Patent Application.

2. The objection to the drawings under 37 CFR 1.83(a) has been addressed by adding the cap layer 25 to figures 2h and 3g and amending the specifications to delete the term "(not shown)" and to add numeral 25 to the cap layer.

4. Reconsideration of the rejection of Claims 1-2, and 4, 6, 10–12 under 35 U.S.C. 103(a) as being unpatentable over Lin (US 6,093,656) in view of Rathore et al. (US 6,069,068) and Datta et al.(US 5,567,300) is requested, in light of the following arguments.

Whereas there are similarities with regards to (1), there is no similarity with Lin regarding point (2). Lin's teaching that the blanket deposition of copper "could be done in a number of different ways..." in no way teaches anything. If Lin had known of any other method Lin would have certainly been more specific and mentioned those "different ways". It appears to Applicant that Lin is then teaching away because nobody after Lin then could suggest any other way of blanket deposition of copper. Yet Lin clearly admits that he does not know of another method but suspects there might be one, one he is not aware of. These are the musings of an inventor inviting others to search for *different ways*. This is exactly what Applicant has done in his invention.

Further regarding (2), while there are similarities between Rathore et al. and Applicant's invention, the methods of Rathore et al. strictly address the filling and planarization of copper interconnections while Applicant's invention solves the problem of global planarization of a substrate by etching away that part of the copper layer and barrier metal layer not covered by the reverse tone photoresist mask. Thus areas without trenches are free of copper, reducing subsequent CMP and, therefore, eliminating dishing of the conductor filled trenches.

Regarding (4), while a cap layer may be a step in damascene methods, the cap layer is only one aspect of Applicant's method. The fact that Applicant's invention parallels some aspect of the prior art does not detract from the unique feature of Applicant's invention– i.e., the reverse tone photoresist mask–as detailed above, but sets it apart from Rathore et al. and Lin. The same argument holds for the need of a copper seed layer per Rathore. Applicant maintains that his invention is unique and not obvious.

Regarding (3), while Datta et al. teaches reverse electroplating and its benefits, including various planarization methods, Applicant has improved upon these methods by etching away parts of the copper layer and barrier metal layer not covered by the reverse tone photoresist mask. The effect is that dishing is eliminated because far less polishing is required.

Applicant believes the above facts fully demonstrate that his invention is unique and not obvious to a person of ordinary skill in the art, and that it is a better method of planarizing copper damascene. None of the references recited by the Examiner individually suggest Applicant's invention and it is only the combination of these several references that suggest to the Examiner that a person of ordinary skill in the art could have modified these references to arrive at Applicant's invention. Based on the arguments above, Applicant believes that claim 1 is now allowable.

Regarding claim 4, as argued above, independent claim 1 is believed allowable, therefore, dependent claim 4 is also believed allowable.

Regarding claim 6, as argued above, independent claim 1 is believed allowable, therefore, dependent claim 6 is also believed allowable.

Regarding claims 11 and 12. The critical dimensions are a result of experimentation rather than routine optimization as Examiner alleges. Applicant has not found in Lin's discussion of the reverse tone photoresist mask any reference where Lin makes clear or alternatively suggests Applicant's "critical dimensions". Lin merely states (in col. 3, line 65-67): "*Generally, it has been determined that a positive photoresist can transfer smaller patterns so it is better for smaller line widths than a negative photoresist.*" Lin simply repeats a fact known by those skilled in the art but does not teach when reverse photoresist can cover spaces between damascene trenches when the trenches are separated by less than a critical dimension, i.e.,

dimensions ranging from 0.05μm to 0.2μm. As argued above, independent claim 1 is believed allowable, therefore, dependent claims 11 and 12 are also believed allowable.

5 Examiner's *Response to Arguments* have been noted but Examiner's conclusions are not agreed with.

6. We have reviewed the two related art references made of record and not relied upon by the Examiner and feel that neither of these suggest the present claimed invention.

Fiordalice et al., US 5,578,523.

Bernhardt et al., US 5,256,565.

All claims are now believed to be allowable.

It is requested that should Examiner Kielin not find that the Claims are now Allowable that he please call the undersigned attorney at (845) 452-5863, to overcome any problems preventing allowance.

Respectfully submitted,

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VERSION WITH MARKINGS TO SHOW CHANGES MADE

In the Specification:

The paragraph beginning at page 9, line 14, has been amended as follows:

In the next step, FIG. 2f, the photoresist is stripped away, exposing the electroplated copper 18. The copper dual damascene 18 and barrier metal layer 16 are next planarized by CMP. FIG. 2g shows the copper partially removed by CMP and FIG. 2h shows the copper dual damascene 18 and metal barrier layer 16 after completion of CMP where the copper dual damascene 18 is completely coplanar with the upper surface and without any dishing in the trenches 12, 13, 14, and 15. In a last step [not shown] the copper dual damascene is sealed with a cap layer 25, such as nitride or oxynitride. The copper layer 18 can be replaced by a layer of metal from the group comprising gold, aluminum, tungsten, titanium, or silver.

The paragraph beginning at page 10, line 14, has been amended as follows:

Now referring to FIG. 3c, the photoresist is applied and a reverse tone photoresist mask 39 is formed. Note that the same numbers in FIG. 2 and FIG. 3 identify the same component. As shown in FIG. 3c, there is no photoresist between trenches 32, 33, 34, and 35, because the reverse tone photo mask of the metal lines is

used which by definition covers only those parts of the copper layer that are in the trenches. Next, see FIG. 3d, follows etching the copper layer 18 and barrier metal layer 16 from areas not covered by the reverse tone photoresist mask. Etching can be achieved using a dry anisotropic etch typically with chlorine (Cl2) as the etchant or using a wet isotropic etch typically with nitric acid (HNO3) as an etchant. Note that copper has been etched away from areas 20, 21, 22, and 23. In FIG. 3e the photoresist has been stripped exposing the deposited copper 18 underneath. The copper damascene 18 and barrier metal layer 16 are next planarized by CMP. FIG. 3f shows the copper partially removed during CMP and FIG. 3g shows the copper damascene 18 and metal barrier layer 16 after completion of CMP where the copper damascene 18 is completely coplanar with the upper surface and without any dishing in trenches 32, 33, 34, and 35. A last step [not shown] is the sealing of the copper damascene with a cap layer 25, such as nitride or oxynitride. The copper layer 18 can be replaced by a layer of metal from the group comprising gold, aluminum, tungsten, titanium, or silver.

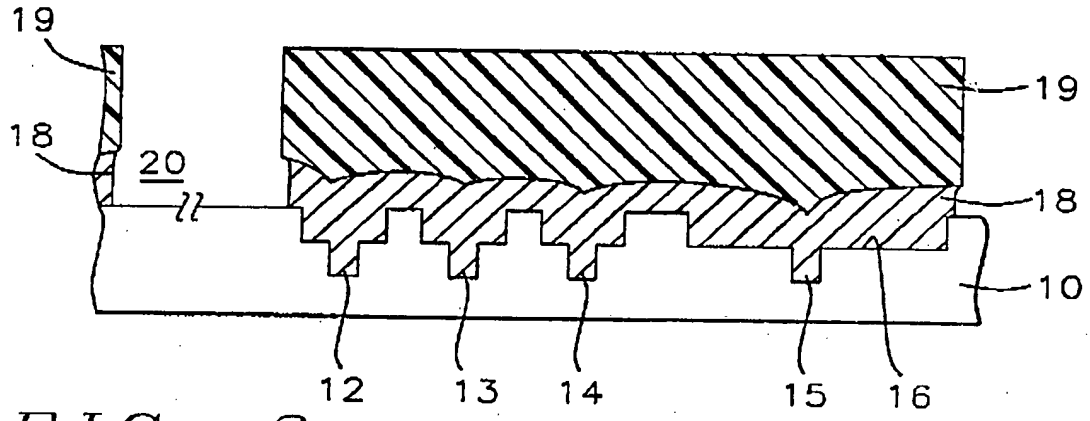

FIG. 2e

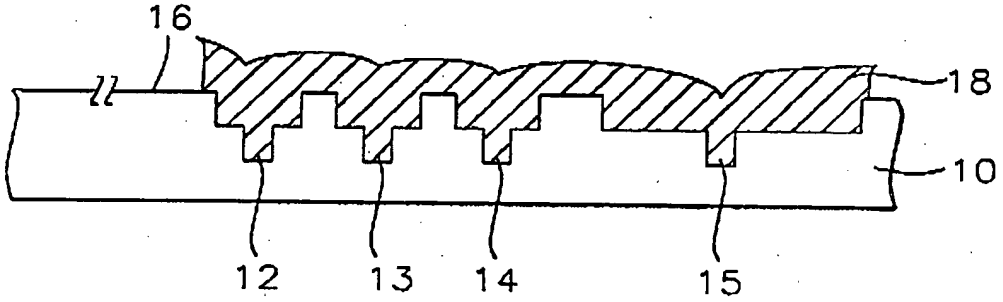

FIG. 2f

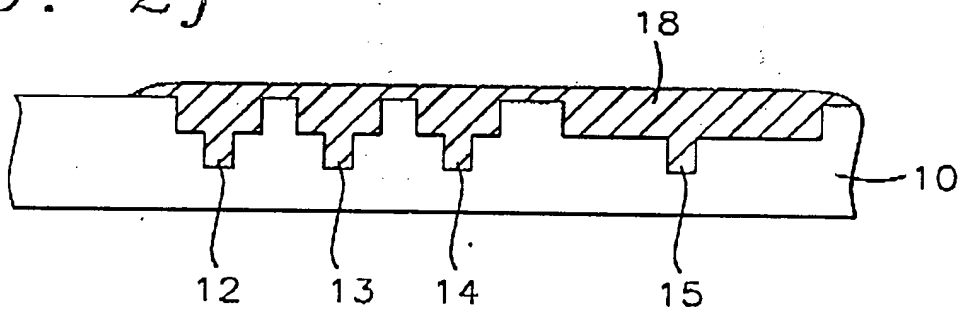

FIG. 2g

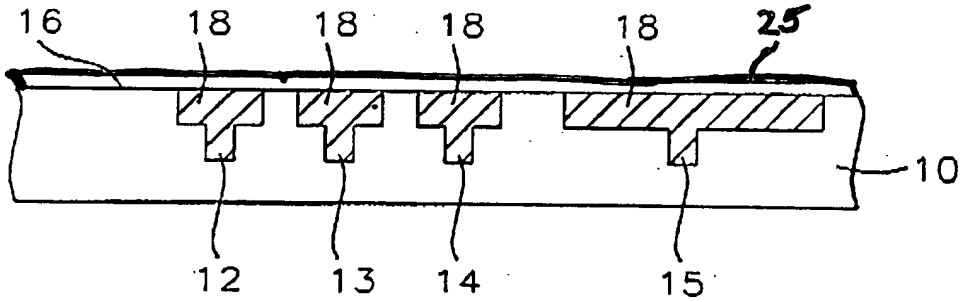

FIG. 2h

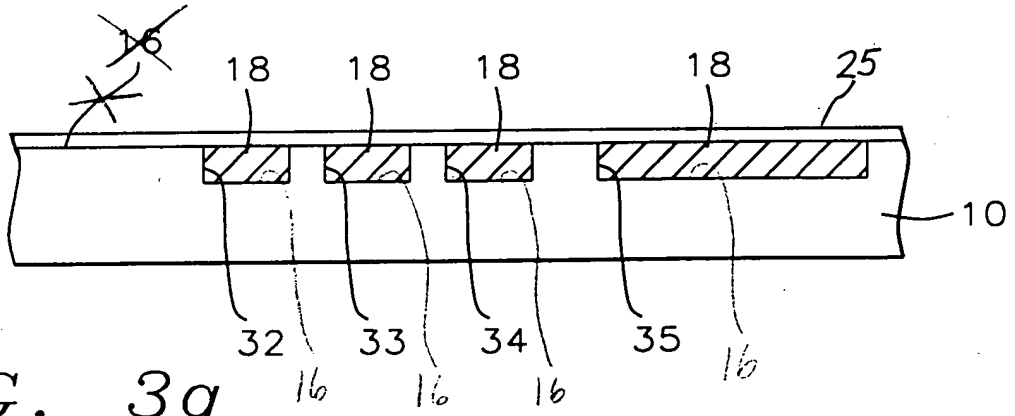

FIG. 3g

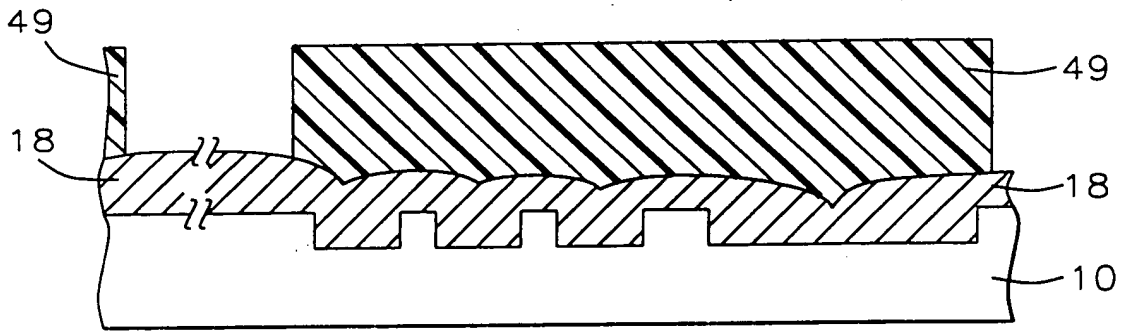

FIG. 4a

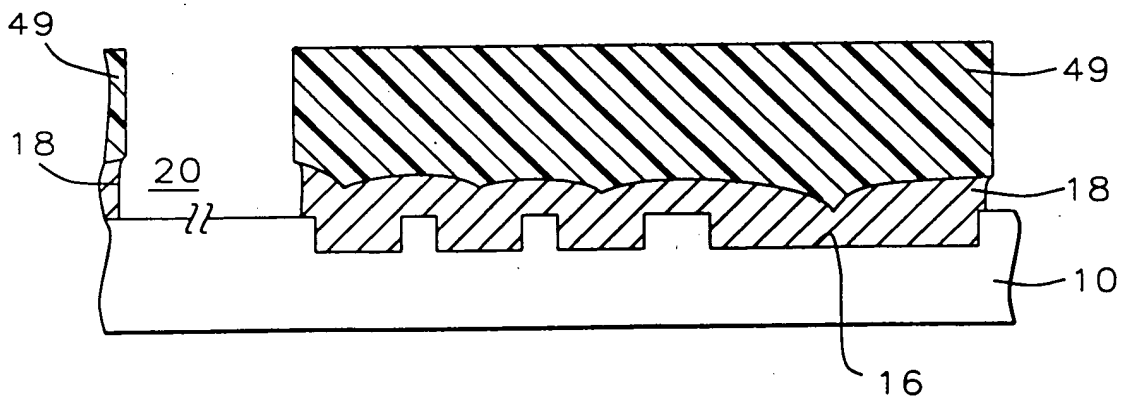

FIG. 4b